

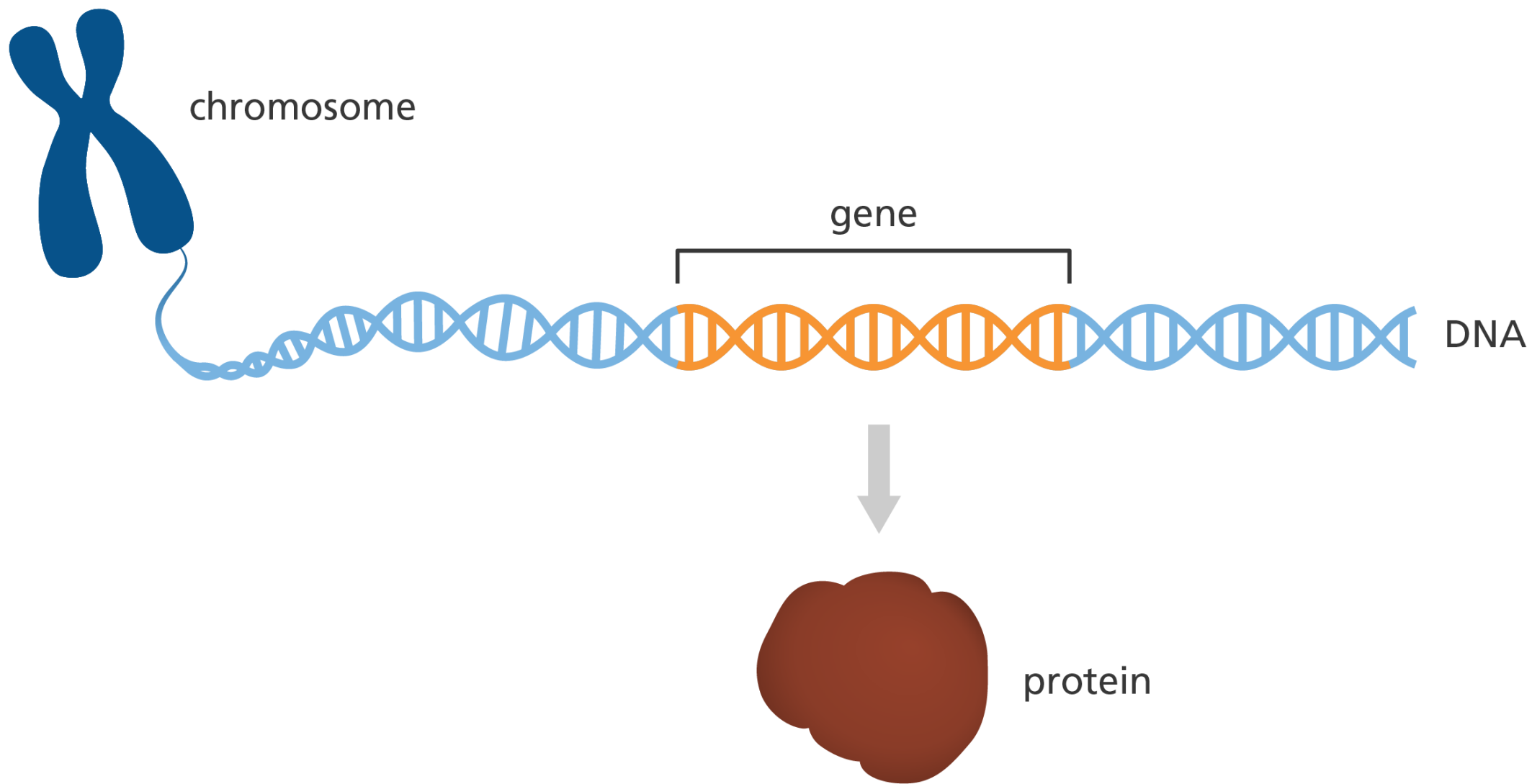
Cell Biology, Genetics and Evolution

Nature of Gene and Genetic Code

By: Shozab Seemab Khan (PhD Scholar)

Nature of Gene

- ❖ A gene is a basic unit of heredity, responsible for controlling a specific characteristic or function in an organism.
- ❖ It consists of a segment of DNA that contains the instructions to make proteins, which are the building blocks and workers of the cell.



Nature of Gene

❖ A. Location and Structure

- ❖ Genes are segments of DNA, which is made up of nucleotides (the building blocks of DNA).
- ❖ Each nucleotide consists of a sugar, a phosphate group, and one of four nitrogenous bases:
- ❖ Adenine (A), Thymine (T), Cytosine (C), and Guanine (G).
- ❖ **Locus:** Each gene is located at a specific position, called a locus, on a chromosome.

Nature of Gene

❖ B. Function of Genes

- ❖ **Protein coding:** Most genes contain the instructions to make proteins. The sequence of nucleotides in a gene determines the sequence of amino acids in a protein, which in turn determines the structure and function of that protein.
- ❖ **Non-coding regions:** Some genes, however, do not code for proteins. Instead, they might be involved in regulating other genes or making molecules like RNA (such as tRNA or rRNA) that have roles in the protein synthesis process.

Nature of Gene

❖ C. Alleles

❖ **Variations:** A gene can exist in different versions, called alleles. For example, the gene for eye color can have alleles for blue or brown eyes. These alleles cause differences in traits.

❖ D. Inheritance

❖ Genes are passed from parents to offspring. Each individual inherits two alleles for each gene—one from each parent. These alleles interact to determine the organism's traits.

Genetic Code

- ❖ The genetic code is a set of rules used by cells to translate the information in a gene (DNA or RNA) into proteins. Proteins are made of amino acids, and the genetic code tells the cell which amino acids to use and in what order.
- ❖ **A. Triplet Code (Codons)**
- ❖ Codons: The genetic code is read in groups of three nucleotides, called codons. Each codon corresponds to a specific amino acid or a stop signal during protein synthesis.

Genetic Code

- ❖ 1. A triplet code comprised of three nucleotide bases in a sequence.
- ❖ 2. How many triplet codes?
- ❖ 20 common amino acids in a protein
- ❖ 4 different bases on DNA A, T, C, & G
- ❖ 4 different bases on RNA U, A, G, & C
- ❖ Total 64 Codons

Why Triplet Code

- ❖ The logic is that the nucleotide code must be able to specify the placement of 20 amino acids. Since there are only four nucleotides, a code of single nucleotides would only represent four amino acids, such that A, C, G and U could be translated to encode amino acids.
- ❖ A doublet code could code for 16 amino acids (4×4). A triplet code could make a genetic code for 64 different combinations ($4 \times 4 \times 4$) genetic code and provide plenty of information in the DNA molecule to specify the placement of all 20 amino acids.

Why Triplet Code

Type of code	Number of permutations
Singlet	$4^1 = 4$
Doublet	$4^2 = 16$
Triplet	$4^3 = 64$
Quadruplet	$4^4 = 256$
Pentuplet	$4^5 = 1024$

Only the triplet code really looks feasible

Genetic Code

- ❖ For example, the RNA codon AUG (ATG in DNA) codes for the amino acid methionine, which is often the start signal for protein synthesis.
- ❖ The codon UAA is a stop signal, meaning it tells the cell to stop building the protein.
- ❖ **B. Redundancy**
- ❖ The genetic code is redundant, meaning that multiple codons can code for the same amino acid. For example, both GAA and GAG code for the amino acid glutamic acid.
- ❖ This redundancy helps protect against mutations—if one nucleotide changes, it might not always affect the amino acid being produced.

Genetic Code

❖ C. Universal Code

- ❖ The genetic code is universal for nearly all organisms, from bacteria to humans. This means that a codon like AUG will code for methionine in almost every living organism, making the code highly consistent across life forms.
- ❖ It is used as evidence of evolution.

Genetic Code

❖ D. Translation Process

- ❖ The mRNA (messenger RNA) transcribes the genetic information from DNA and takes it to the ribosome, where the codons are read and translated into a chain of amino acids (a protein).
- ❖ tRNA (transfer RNA) brings the correct amino acids to the ribosome by matching its anticodon with the mRNA codon.
- ❖ The ribosome assembles the amino acids in the correct sequence to form the protein.

Genetic Code

❖ E. Start and Stop Codons

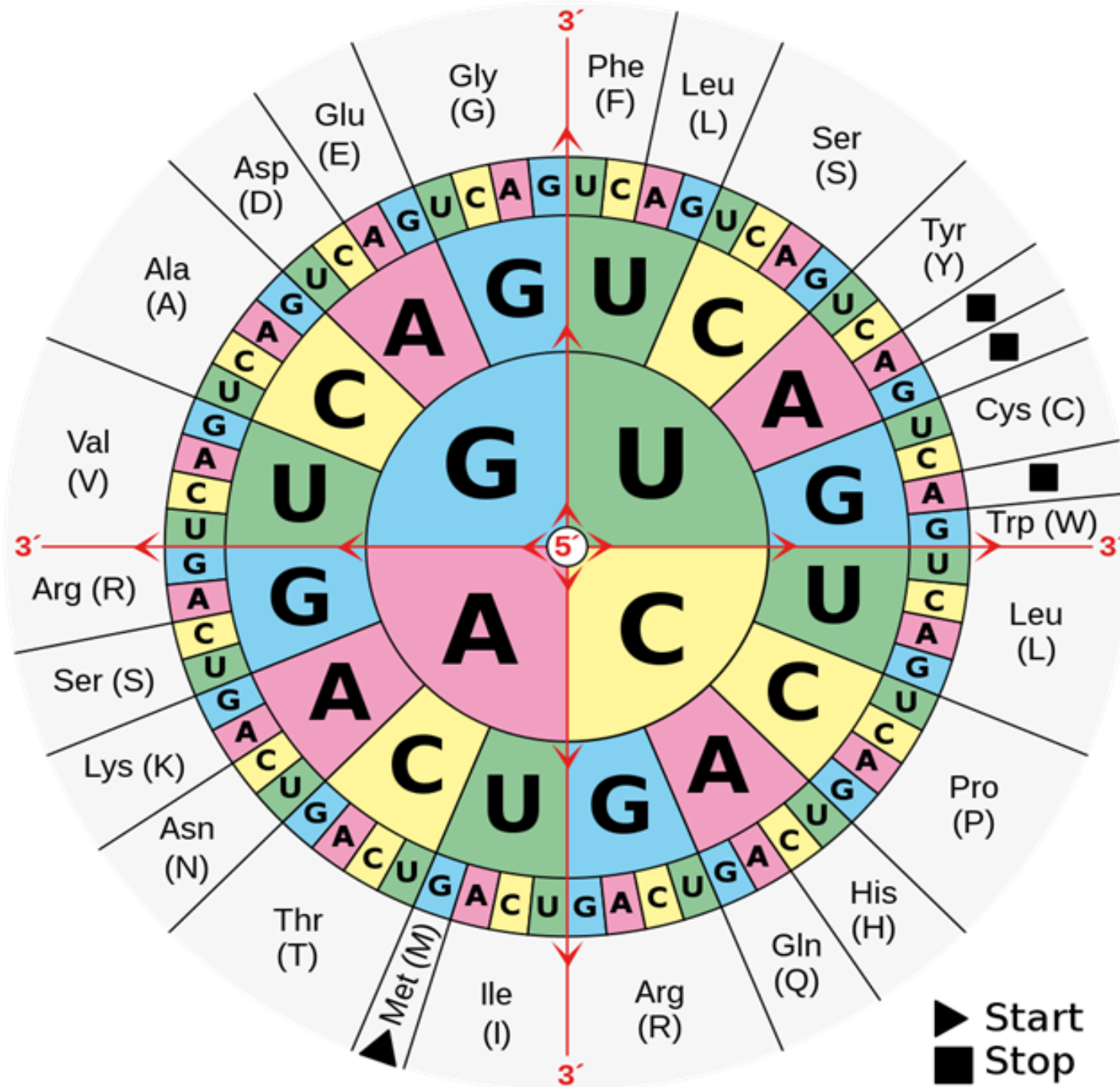
❖ Start codon:

❖ The codon AUG signals the start of translation and also codes for methionine.

❖ Stop codons:

❖ Codons like UAA, UGA, and UAG do not code for any amino acid and signal the end of translation, stopping the protein-building process. They are also called non-sense codons.

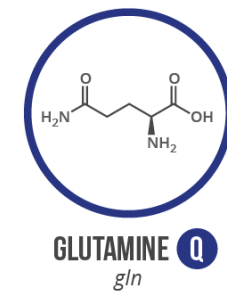
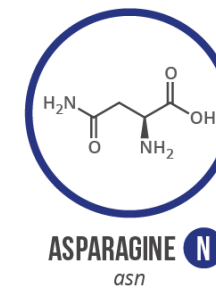
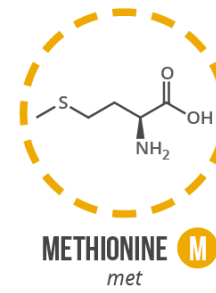
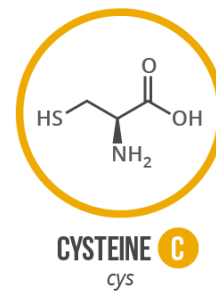
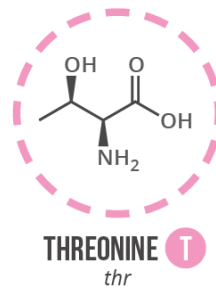
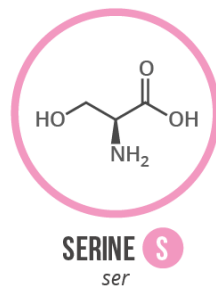
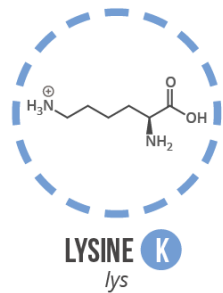
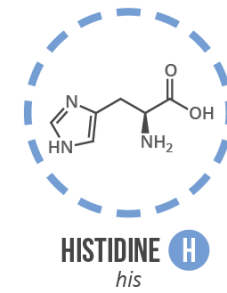
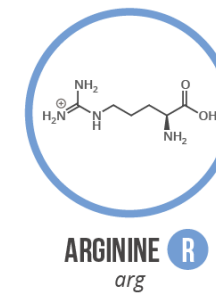
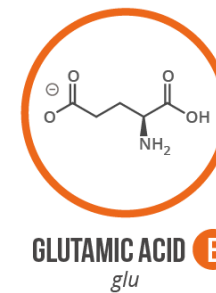
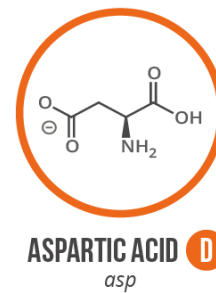
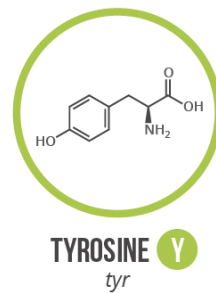
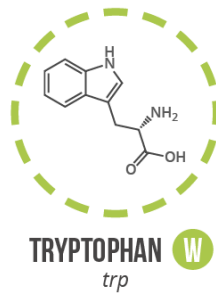
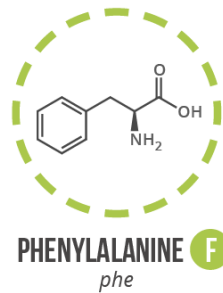
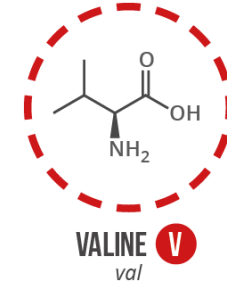
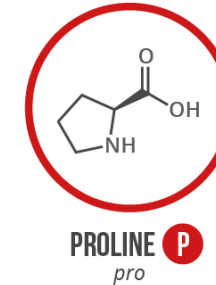
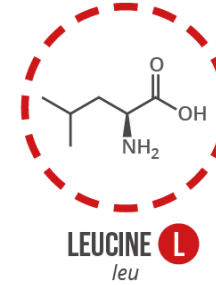
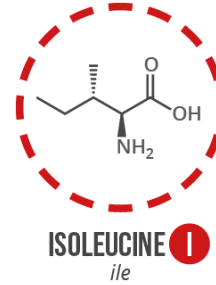
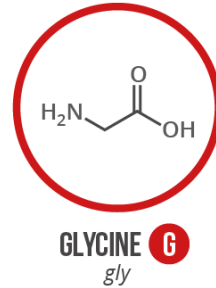
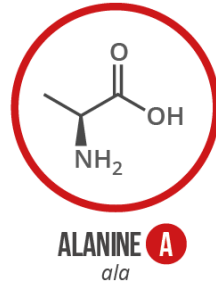
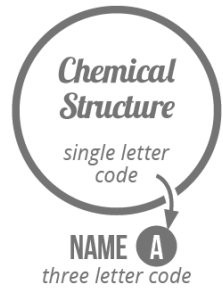
		Second letter				
		U	C	A	G	
First letter	U	UUU } Phe UUC } UUA } Leu UUG }	UCU } UCC } Ser UCA } UCG }	UAU } Tyr UAC } UAA Stop UAG Stop	UGU } Cys UGC } UGA Stop UGG Trp	U C A G
	C	CUU } CUC } Leu CUA } CUG }	CCU } CCC } Pro CCA } CCG }	CAU } His CAC } CAA } Gln CAG }	CGU } CGC } Arg CGA } CGG }	U C A G
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A GUIDE TO THE TWENTY COMMON AMINO ACIDS

AMINO ACIDS ARE THE BUILDING BLOCKS OF PROTEINS IN LIVING ORGANISMS. THERE ARE OVER 500 AMINO ACIDS FOUND IN NATURE - HOWEVER, THE HUMAN GENETIC CODE ONLY DIRECTLY ENCODES 20. 'ESSENTIAL' AMINO ACIDS MUST BE OBTAINED FROM THE DIET, WHILST NON-ESSENTIAL AMINO ACIDS CAN BE SYNTHESISED IN THE BODY.

Chart Key: ● ALIPHATIC ● AROMATIC ● ACIDIC ● BASIC ● HYDROXYLIC ● SULFUR-CONTAINING ● AMIDIC ○ NON-ESSENTIAL ○ ESSENTIAL



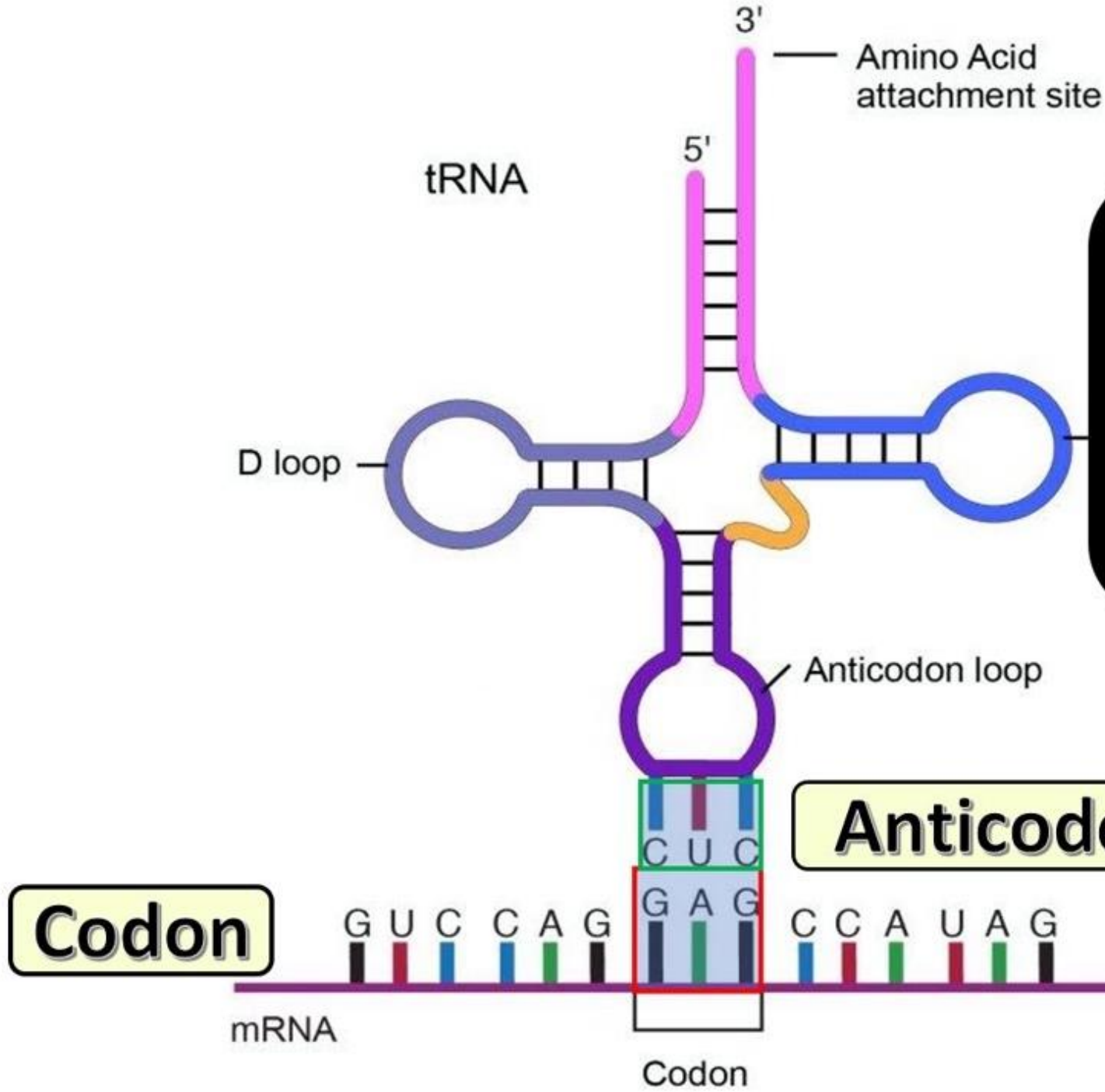
Note: This chart only shows those amino acids for which the human genetic code directly codes for. Selenocysteine is often referred to as the 21st amino acid, but is encoded in a special manner. In some cases, distinguishing between asparagine/aspartic acid and glutamine/glutamic acid is difficult. In these cases, the codes asx (B) and glx (Z) are respectively used.

Anticodon

- ❖ An anticodon is a sequence of three nucleotides found in a molecule of transfer RNA (tRNA). Its primary function is to pair with a complementary codon on a messenger RNA (mRNA) during the process of translation in protein synthesis.
- ❖ **Codon:** A triplet of bases on mRNA that specifies an amino acid.
- ❖ **Anticodon:** A triplet of bases on tRNA that is complementary (opposite) to the mRNA codon.

Anticodon

- ❖ Each anticodon on tRNA matches a specific codon on mRNA.
- ❖ The tRNA carries an amino acid that corresponds to the codon it pairs with.
- ❖ This pairing helps ensure that the correct amino acid is added to the growing protein chain.
- ❖ For example, if the codon on mRNA is AUG (which codes for methionine), the anticodon on tRNA will be UAC, and the tRNA will carry methionine.



Codon vs Anticodon



*Thank
You!*